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Automatic Crash Notification

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ABSTRACT

This report presents information relating to a vehicle technology commonly referred to as Automatic Collision (or Crash) Notification (ACN) as well as its relevance in South Australia. The purpose of this vehicle technology is to identify that a collision has occurred and automatically relay the crash notification and location to a third party to initiate a response by emergency medical services. The potential benefit of this system may come from reductions in emergency notification times and a reduction in any uncertainty that emergency services might otherwise have regarding the location of the crash. The analysis presented in this report conservatively estimated that if ACN was fully deployed in the vehicle fleet, road crash fatalities in South Australia in the period 2008-2009, may potentially have been reduced by 2.2% - 4.4%.

KEYWORDS

Automatic Collision Notification, Automatic Crash Notification eCall

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Summary

This report presents information relating to a vehicle technology commonly referred to as Automatic Collision (or Crash) Notification (ACN) as well as its relevance in South Australia. The purpose of this vehicle technology is to identify that a collision has occurred, and then to open a line of communication between the driver and/or vehicle and emergency services (often through a telematics service provider). An automated message provides an exact location. In the event that no voice communication with the vehicle occupants can be established, or if the vehicle occupants require it, emergency services can be coordinated.

The potential benefit of this system may come from reductions in emergency notification times and a reduction in any uncertainty that emergency services might otherwise have regarding the location of the crash.

This report examined several areas related to ACN. A literature review of ACN systems as well as a review of some evaluations of the potential benefits of these systems was undertaken. Also documented in this report is an estimate of the potential benefits of ACN in South Australia, based on a sample of fatal crashes. Separately, a sample of serious injury and fatal crashes in SA was examined against mobile phone cellular coverage maps, recognising that part of the performance of an automatic notification system is dependent upon its ability to make a notification through such a network. Finally, the current and future deployment of ACN is briefly summarised.

The international literature reports a range of ACN effectiveness: estimates range from a 2.8% reduction in fatalities to an 11.9% reduction in fatalities. A study reviewed in this report, specifically pertaining to Australia, estimated an effectiveness of between 10.5% and 12.0% per year although there are reasons to be cautious regarding the methodology employed.

According to our analysis of fatal crashes in South Australia, we conservatively estimate that the effectiveness of ACN in reducing fatalities to be between 2.2% - 4.4% per year. There may be a few additional cases where ACN may have been effective, but which we could not identify, and hence effectiveness might be marginally higher than we have been able to estimate. Network coverage is part of the reason that effectiveness is not higher, although ubiquitous mobile communication may also be a reason that the benefits of ACN are also restricted.

Contents

1 Introduction

Since the introduction of mobile communication devices, notification times of critical incidences such as motor vehicle crashes have, without doubt, vastly improved. A high proportion of motorists have instant access to mobile communication devices to the point where a single vehicle crash on a busy urban road can often result in multiple notifications to emergency medical services for a single event. Sihvola et al. (2009) quote Reinhardt et al. (2002) that 70% of road accidents are reported by people other than those involved in the accident.

The ability to automatically activate an emergency medical response with minimal delay after a crash has occurred can be initiated with a vehicle technology commonly referred to as Automatic Crash Notification (ACN) (also referred to as eCall, mostly in Europe). Such systems have gained attention for their potential to improve times-to-treatment and for the claims that have been made regarding their utility in reducing road deaths through the greater opportunity for timely treatment.

In the period 2010-2011, the response times of the SA Ambulance Service to life-threatening cases was within 8 minutes in 60.3% of cases attended in urban centres[1] and within 16 minutes for 91.6% of life-threatening cases (SA Ambulance Service, 2011).

Evanco (1996) suggests that the effectiveness of the emergency response to a crash or other incident can be measured by the elapsed times occurring in the various phases of operations that occur between the occurrence of the crash and the delivery of the injured person(s) to an emergency department. These include the period between the occurrence of a crash and notification of the Emergency Medical Service (EMS) (the “accident notification time”), the period between EMS notification and arrival at the crash scene, and the period between EMS arrival at the crash scene and arrival at hospital. The accident notification includes “determination that an accident has occurred, the verification of the location and nature of the accident, and reporting of this information to the appropriate authorities” (Evanco, 1996, p1-1). Evanco (1996) also suggests that the time components of the emergency response relate to the injury outcome.

NHTSA (2001) refers to the initial period of time as the “notification time”, which incorporates the decision, contact and call period to emergency services. The decision period commences at the moment of injury and extends to the moment of recognition by a crash participant or a third party that emergency assistance is required. This period according to NHTSA (2001): “… varies greatly and is dependent on a number of factors including time of day, population density, traffic density, and random chance.” This variation was evident within the present study.

Each period of time is critical within the context of medical treatment, and while response time is the most important aspect from an emergency service operational perspective, a pre-requisite or “trigger” for the response is recognition of the occurrence of a crash and notification of the appropriate agencies.

Akella et al. (2003) documents the discrete time elements from the moment a crash occurs to the moment where an injured person can receive the most appropriate medical treatment within a local hospital or emergency hospital. These are:

- *t0* Crash occurrence
- *t1* Notification receipt by Emergency Response
- *t2* Emergency Medical Service (EMS) notified

[1] Adelaide, Gawler, Bridgewater-Crafers, Murray Bridge, Mount Gambier, Port Pirie, Port Augusta and Port Lincoln, SAAS Annual Report 2010-2011

- *t3* EMS dispatched
- *t4* EMS arrival to crash scene
- *t5* EMS gain access to patient(s)
- *t6* EMS depart scene
- *t7* EMS arrival at Hospital

While response time is important in injury management it is but one critical element in the sequence of events that may determine the time between a crash and hospital emergency department treatment. If ACN has benefit in a crash, it is through reducing the time between *t0* and *t1*.

1.1 Outline of this report

This report reviews various ACN trials and implementations, and the estimates of the benefits that have been found when ACN has been adopted. Three analyses are then presented:

- First, the emergency medical services (EMS) notification times in South Australian fatal crashes are reported.
- Second, an in-depth analysis was conducted of fatal crashes in which there was a delay between the crash and EMS notification, to identify any cases in which ACN may have changed the outcome of the crash.
- Third, locations of serious and fatal crashes in South Australia were compared with cellular network coverage information, to examine in what proportion of crashes ACN might have been activated had the vehicles involved been equipped with such a device.

Finally, current commercial systems are described.

1.2 How the system works

According to Austroads (2004) Automatic Collision Notification “refers to technology designed to detect the involvement of a motor vehicle in a crash, to obtain information about the severity of the crash where possible, and to notify emergency response personnel either automatically or through a response centre”.

Three key basic mechanisms of an ACN system are collision detection, location identification and subsequent notification of the collision and location. Sophisticated supplementary vehicle safety systems exist in most new cars today that enable detection of collisions of sufficient severity that warrant deployment of the required safety system (airbags, seat-belt pre-tensioners etc.). Location information and communication of this information can be enabled through an integrated in-vehicle telematics system.

According to the National Transport Commission (2010), "In-vehicle telematics describes the processing and communications systems that enable two-way communications between vehicles, between vehicles and infrastructure, and ultimately with other information technology systems used in the transport and logistics industry ... At a minimum, these systems require a location sensing device for the vehicle and a control unit that is interfaced to the vehicle’s electronic systems. This applies to both freight vehicles and passenger vehicles. These minimum requirements can be – and often are – augmented by sensors that monitor variables..."

In the case of ACN systems these sensors are those described above that are used for collision detection, or additional sensors supplementary to, or integrated with an ACN system.

Current Australian ACN systems are integrated with vehicle telematics systems, and are monitored by a telematics service provider (TSP) on a paid subscription basis (See Section 5 for further details). The telematics system consists of a two-way communication device (integrated cellular phone system), a tracking device (Global Positioning System) and programmed hardware that is integrated with specific components of the electrical system of the vehicle. The telematics hardware can be programmed to detect any specific vehicle electrical signal that can be used to classify 'events'. These signals can include battery disconnection, low battery voltage, vehicle service reminders, airbag deployments, etc. Information about 'events' are then transmitted via the telematics communication system based on specific protocols, to a contracted TSP. The TSP engages agreed protocols based on the nature of the event. Depending on the event, a voice communication link can then be made between the TSP and the driver of a vehicle through the two-way phone system, or the TSP can directly communicate with the vehicle electrical system (for example if a vehicle is stolen, the telematics service provider can, via Police authority, cut power to the vehicle's engine).

In the case of a vehicle collision, the telematics hardware usually recognises such an event through an airbag deployment (although systems can be programmed for other crash indicators), and the TSP is alerted. The vehicle telematics module automatically generates a short message service (SMS) text containing relevant information and this is transmitted through a cellular network such as the global system for mobile (GSM) communication network.

The information transmitted includes the location of the crash (global positioning system (GPS) coordinates), unique vehicle ID, vehicle owner details and the event type. This information is transmitted to the TSP and voice communication is then attempted with the vehicle's driver through the vehicle integrated hands free cellular phone system. Based on communications with the driver (or other occupants) the TSP can directly assist the driver. The TSP operator will try to ascertain the wellbeing of the occupants, and they will ask whether they require emergency assistance. If no communication is established, or if the occupants request emergency services, the TSP emergency protocol is engaged.

In Australia, the emergency protocol (according to Intelematics Australia Pty Ltd., the leading provider of such services in Australia), involves calling triple-zero, and passing information from the vehicle message to the triple zero operator. Police communications can be connected to the vehicle, and they can coordinate the appropriate emergency medical response.

2 Literature Review

2.1 National Highway Transport and Safety Administration research

One of the first references to ACN can be found in Donnelly et al. (1995). The authors discuss ACN as part of a National Highway Transport and Safety Administration's (NHTSA) sponsored project. ACN systems were designed, developed, tested, and were installed in 700 vehicles. While the crash notification method was similar to that outlined in the previous section, the crash detection mechanism and the data collected and transmitted were different. The ACN system used three accelerometers that could detect impacts from any direction and vehicle roll-over. Once a collision was detected, a voice line was opened with the County Sheriff's office. The following information was also received:

- Crash time
- Ten second vehicle location and speed history prior to crash
- Icon with principal direction of force (PDOF) and whether a roll-over has occurred
- Crash change in velocity (delta-V)
- Vehicle final rest position (vehicle orientation)
- Estimate of probability of serious injury (if desired/required)

The system was able to reduce the time in alerting emergency services to less than two minutes and the most effective application of the system was recognised by the authors as being able to assist in "remote locations where a crash may not be observed and reported" or where there was an absence of a telephone.

The NHTSA "URGENCY" algorithm and its history is summarised by Champion et al., (2004). It was developed through a NHTSA convened "multi-disciplinary team of trauma surgeons, emergency physicians, crashworthiness engineers and statisticians to improve triage, transport and treatment of people injured in crashes" (Champion et al., 2004). By using the principal direction of force and delta-V from the vehicle sensors, the algorithm can be used to determine the probability of serious injuries in a crash. EMS dispatchers can then use this information to quickly identify whether occupants in a particular crash required urgent medical attention (Champion et al., 2004).

The usefulness of such information (and the likelihood that it will become even more available in the future) has resulted in the addition of such information as a part of the US triage criterion (US Department of Health and Human Services, 2008). It is therefore particularly important that the algorithm can distinguish the approximately 250,000 vehicles involved in serious injury crashes from the 28,000,000 crashed vehicles with minor or no injuries per year in the US (Champion et al., 2004). Specific details on the development and validation of the algorithm can be found in Augenstein et al. (2001).

2.2 European Parliament research (eCall)

In June 2012, a motion for a European Parliament Resolution was made on "eCall" (European Parliament, 2012a). The resolution "urges the (European) Commission to table legislation to make eCall mandatory by 2015" (European Parliament, 2012b).

The principles of eCall are similar to the ACN and AACN systems described above. In the event of a serious crash an emergency call is triggered (or can be manually triggered) and a voice link is established with the closest emergency service as well as sending an emergency message containing a minimum set of data (MDS) including the time, location of the crash and vehicle identifiers (European Parliament, 2012b).

The history of eCall in Europe is quite detailed, and cannot be comprehensively addressed here, however many of the essential elements are summarised in a report by the European Parliament (2012b). Some key elements include:

- A voluntary approach to deployment of eCall was part of "Commission Policy" since 2003. Significant progress had not been made by the end of 2009, and while private in-vehicle emergency call systems exist (as part of telematics packages as discussed above) and their deployment is increasing, market penetration is below 0.4% of the vehicle fleet.
- The benefits of eCall transgress country borders and language barriers (particularly in Europe) with automatic notification of crashes with location and MDS, particularly useful for cross country travellers.
- The benefits of eCall, according to 'official statistical data' has the potential, with full integration, to save 2,500 lives annually and reduce severity of injuries by 10-15%. While improving emergency response times and incident management, other environmental benefits can also be expected by reducing congestion due to attending to crashes more promptly.
- The EU parliament have said that eCall should be public, free of charge, obligatory and utilise the EU-wide emergency call system (based on the European wide 112 emergency call number). It should be simple, reliable, high quality, affordable and accessible throughout Europe regardless of vehicle, location and human needs.

2.3 Manufacturer programs and devices

2.3.1 Subscription based

Telematics service providers, telematics system functions and advisory services, are (generally) initially provided on a 'trial basis' or 'gifted' for a period of time (usually for the vehicle warranty period), on-going provision of these services, including ACN, is on a paid subscription basis.

In 1996, OnStar was launched in the US (OnStar, 2010) as a "wholly-owned subsidiary of General Motors (GM)". According to GM (2012) "OnStar was the industry's first embedded telematics system when it debuted in 1996. OnStar in GM vehicles was the first available comprehensive automatic crash notification and security system". The collision notification system is part of the telematics package and can be activated manually though an emergency button which places a priority call to an OnStar advisor who then renders necessary assistance by contacting the nearest emergency service provider (Koudal et al., 2004). The original OnStar/GM ACN system was based on airbag deployment using the airbag sensors, which then automatically notified OnStar services of a vehicle airbag deployment and GPS location so OnStar could arrange appropriate emergency service response (Verma et al., 2007).

Not all crashes result in an airbag deployment, and not all crashes with an airbag deployment require emergency assistance (as identified in-depth crash investigation, CASR in-depth studies 1995 - current). The basic ACN evolved to identify different crash severities as well as rollover crashes. The

‘Advanced Automatic Crash Notification’ (AACN) system was introduced by OnStar in GM vehicles (Verma et al., 2007), expanding the criteria for notification beyond airbag deployment alone.

In the AACN, the ‘computational engine’ of the system is a centrally located Sensing Diagnostic Module (SDM) which is connected to strategically placed vehicle sensors used for front and side airbag deployments, and seat belt pre-tensioners (Verma et al., 2007; Butler, 2002). The SDM also contains internal accelerometers which are used to measure the magnitude and direction of the impact forces in a crash as well as to estimate delta-V (Butler, 2002). Delta-V is often used as an indicator of crash severity as well indicating the likelihood of a particular injury severity in vehicle crashes. NHTSA (2005) related crash vehicle impact speed or delta-V to risk of occupant injury in the form of a speed-injury risk relationship.

To determine if a collision (with one or more impacts) has occurred, the SDM uses information received from the airbag sensors, or through its own sensing capabilities (Butler, 2002). A crash is identified if the maximum delta-V exceeds a pre-determined crash severity criteria or if a rollover is detected by the rollover sensor (Verma et al, 2007). The information about the collision is then received by the telematics module which is transmitted to OnStar operators for action (Butler, 2002). The information transmitted to the OnStar operators, according to Butler (2002) is a simplification of:

- Magnitude and direction of impact force
- Seat occupancy and seatbelt status
- Rollover and final rest position
- Severity of the crash (according to NHTSA “URGENCY” algorithm)
- Other crash data

In 2005, it was estimated that OnStar had been installed in 200,000 GM vehicles and that OnStar received more than 11,000 vehicle emergencies per month of which 700-900 were due to front airbag deployments (OnStar, 2005). In the first 15 years of operation, OnStar responded to more than 146,000 automatic crash notifications “where a driver was unresponsive after an airbag deployment” (OnStar, 2010). After 17 years, OnStar had responded to over 191,000 automatic crash notifications (OnStar, 2012).

BMW vehicles have utilised ACN in their vehicles since 1997, and recorded 14,008 ACN crashes in the period 2006-2008. Since 2007, BMW have utilised Enhanced ACN systems (Rauscher et al., 2009). The BMW system also incorporates the URGENCY algorithm/computation. Rauscher et al. (2009) state:

> “The overall predictive accuracy of the model (URGENCY algorithm) suggests that 75.9% of injured occupants would be correctly identified using data automatically collected and transmitted by vehicles alone.”

According to Rauscher et al. (2009), more than 700,000 BMW vehicles world-wide are equipped with the technology, and between their introduction in Germany and the date of the publication, 116 enhanced ACN crash calls had occurred, compared with 449 ACN crash calls in the US since 2008.

Most of the collision notification systems in operation are telematics based, and while OnStar in the US (and since 2008 available in China) seems to be gaining most of the attention, it is important to mention other telematics systems that provide collision notification. While this list is not exhaustive, other systems that exist according to IHS iSuppli (2011):

- In the US, other telematics service providers include ConnectedDrive/BMW Assist on BMW vehicles, Safety Connect/Entune on Toyota Vehicles, Blue Link® on Hyundai vehicles, mbrace on Mercedes Benz vehicles.
- In Europe, telematics service providers include Peugeot Connect, Citroen eTouch (on those respective vehicles) as well as OnCall in Volvo vehicles.
- In Japan, the collision notification system called Help Net[2] is available on Toyota, Lexus, Mazda, Daihatsu, and Subaru vehicles through the telematics service called G-Book.
- In Korea, Mozen services Kia vehicles
- In Russia, the deployment of ERA-GLONASS (Government Accident Emergency Response System) is expected by 2014.

2.3.2 Non-subscription based

Ford has recently introduced Ford "SYNC® 911 Assist™", as part of a broader hands-free navigation/entertainment system on some of its range of vehicles. This system integrates a driver's bluetooth paired smartphone with the vehicle's hands free unit. Little technical information is available, but according to Ford (2011a, 2011b), when a vehicle is involved in a crash with an airbag deployment (or in some vehicles an emergency fuel shut-off) the SYNC® 911 Assist™ system first notifies the driver that 911 will be called, and provides a 10 second time window to prevent this call going through if the driver considers it unnecessary. If the driver does not manually prevent the call being made, the vehicle uses the paired smartphone to call 911, with a pre-recorded message indicating that a vehicle accident has occurred. A voice communication channel is then established (if possible) between the vehicle and the 911 operator.

The original system relied on mobile phone carriers to provide location information to 911 operators, but on some 2011 Ford models (Ford, 2011a) the Sync 911 has been enhanced to allow the 911 operator to manually retrieve the location of the call by following the vehicle's voice prompts. The geographical coordinates are then relayed to the operator via the vehicle's text-to-speech system. The system is currently available in two million vehicles (Ford, 2011a) with plans to introduce the system in Europe in 2012 (Ford, 2011c), with predictions that two million European vehicles will be 'synced' by 2015, in the native language appropriate for the particular country.

The advantage of this system is that there is no additional 'service provider' subscription fee for the vehicle owner. While there have been cases where it has been claimed that the system has been successful in 'saving lives' (see Ford, 2011a), the reliability of the notification systems is only as reliable as the owners handset, and perhaps cannot be assumed to be as robust as a well mounted, well protected, purpose built ACN systems.

[2] There is some informal advice that suggests that no fatality reduction benefits have yet been realised in Japan through the G-Link, Help Net automatic collision notification feature. Most benefit from Help Net has been realised through the manual emergency call feature.

2.4 Aftermarket ACN devices

While the above section discussed in-vehicle installed systems, where ACN is generally part of an overall telematics package or navigation system, a number of other systems exist that have similar functionality and are currently available in the Australian market.

2.4.1 OBD-II systems

OBD-II systems are 'mini telematics devices' that plug into a vehicle's OBD-II connector (On Board Diagnostic Connector). One such system available and supported in Australia is Myionu™. This is a "GPS tracking platform which has been designed to integrate with almost any GPS Tracking device, on any network, anywhere in the world" (Myionu, 2012).

According to information provided by an Australian representative, the basic module consists of a programmable hardware device with an in-built Assisted-GPS that relays GPS related data (location data, vehicle speed data, etc.) to parallel network servers that can be accessed by those with a paid subscription to a particular monitoring service. The method of information relay is via the subscribed service; GSM, Next G®, Wi-Fi, Iridium Satellite or combinations of Next G®/Wi-Fi or Next G® /Iridium Satellite. While this information can be accessed via a third party mapping system (Google Maps), the device can be programmed to send e-mail alerts to interested parties when particular events occur, e.g. exceeding a particular speed limit or driving outside a particular area.

In the context of vehicle collision notification, 'collision detection units' (three-axis accelerometers and angle sensors) can be incorporated within the unit, with e-mail alerts being sent to interested parties (emergency contacts, employers etc.) when programmed protocols are activated, such as when pre-defined thresholds are exceeded.

These thresholds can include acceleration thresholds, which can be configured for harsh braking or collision defined accelerations as well as vehicle rollover thresholds. Temperature sensors (for indication of fires) can also be incorporated into the devices.

2.4.2 Concept/prototype ACN devices

The use of smartphones in the detection of collisions and automatic notification is worth mentioning. Given the prolific deployment of these types of phones in society, and subscription costs to the cellular network already absorbed by owners of these phones, the potential for these devices to assist with the deployment of automatic collision notification devices within the current registered fleet is considerable. Acharya et al. (2008) describe a concept device where wireless sensors can be placed strategically around a vehicle to collect various vehicle parameters (temperature, speed, acceleration, vehicle angle etc.). These wireless sensors are paired with a smartphone or PDA referred to as a NOW client ("Notification by Wireless Systems" client), which monitors the sensor data. When a programmed threshold (e.g. sudden temperature rise or speed drop etc.) is detected, a string of information can be transmitted from the "NOW" client to a "NOW" (remote) server which processes the information and reports the information to Emergency Medical Services.

While only a prototype device has currently been developed and tested, the Sun "SPOT" (Small Programmable Object Technology) has integrated sensors with a GPS. PDA/cell phone sensor and GPS integration is part of the future work.

White et al. (2011), describes a concept, open source, software application that uses a smartphone as a client and again a remote server for data collection and EMS reporting. The ‘client’ relies on the integrated smartphone features; accelerometers, gyroscope, GPS functionality, cellular functionality, processor along with the application software, to detect and identify important parameter thresholds and transmit the critical information to a remote sever for processing and reporting to EMS. White et al. discuss the considerable challenges in developing the concept into a reliable and well functioning system and discuss the limitations that need to be overcome before the system can be considered for deployment.

2.5 Motorcycle ACN devices

ACN devices are primarily intended for passenger vehicles. While registered motorcycles only account for about 4.2% of all Australian registered vehicles (ABS, 2012) they comprise about 15.5% of all road fatalities in Australia in 2011 (BITRE, 2012).

Some work has been done on the development of an appropriate collision notification system for motorcycles. BMW is currently working on a commercial ACN system for motorcycles (BMW Motorrad Emergency Call / Automatic Collision Notification system).

“If the rider of a BMW motorcycle fitted with eCall is involved in an accident himself, this is registered by means of the ACN sensor system and an automatic emergency call is triggered with the BMW Call Center, enabling transmission of the required data, such as location and detailed information on the nature of the accident.” (BMW, 2012).

Finally, a relatively new concept is the ICEdot crash sensor. Specifically designed for attachment to a helmet (for motorcyclists, bicyclists, etc.), the sensor is paired with a smartphone, and if an impact is detected, the phone notifies predefined emergency contacts that an impact has occurred (after a window of time to cancel the notification has expired) with location details (ICEdot, 2012).

2.6 Notification information handling considerations

In several systems, emergency services are contacted by a telematics service provider (TSP) in the case of a crash. Berryman (2004) notes that there are inherent delays and issues associated with TSPs contacting and relaying information from the crashed vehicle to the relevant emergency service.

Berryman (2004) describes a process in which the TSPs rely on manual lookups and dialling procedures to find the relevant emergency service (with over 4,300 such services in the US). Often, the calls are not treated as high priority (compared to 911-direct calls) as they are made through administrative phone lines and location and crash information is reported by voice. This process, according to Berryman, can lead to delays (if administrative phone lines are busy) and errors.

Berryman goes on to describe a project to overcome such problems. A partnership was formed in the US between the Greater Harris County Enhanced 911 Network, the Ford Motor Company, their respective contracted TSP, the local telephone service provider, and a database provider. The partnership “developed and established network elements, processes and switch applications which allow the ACN emergencies to be transferred to the closest 911 [emergency service].”

The system uses a crash detection module that “integrates triaxial accelerometers, cellular communication equipment, GPS devices, enhanced sensors, and crash recognition and characterisation software” (Berryman, 2004).

Once a crash is recognised, the crash information and location details are automatically received by the TSP; the location information is transferred to the database provider to determine the correct emergency service and routing number, and this information is returned to the TSP. Berryman (2004) claims that this 'minimal human intervention' process takes less than eight seconds. The TSP then uses the information to connect to the appropriate emergency service and send all the crash and location information to the service. The service then has access to key crash information, and the crash location is mapped using a local Geographical Information System. Berryman (2004) reports that average total connect and communications time is 35 to 60 seconds, with dispatch of emergency services within two minutes of crash detection.

Seekins, Blatt and Flanigan (2011), discuss how the 'priority access' process described above by Berryman (2004) is being implemented in Montana in the US, in two stages. In the first stage (currently being implemented) the TSP operator is provided with the correct routing number (rather than dialling an administrative number) to allow voice communication of the crash information from the TSP directly to the relevant emergency call centre (911 Public Service Answering Point). The second stage (not currently operational), is in addition to the first stage capabilities, and will also include electronic delivery of selected AACN data to the emergency call centre (Seekins, Blatt and Flanigan, 2011).

Benefits of ACN

Automatic vehicle Collision Notification systems have the potential to eliminate the delays associated with notification of a serious injury crash to emergency services, as well as eliminating any ambiguity in the reported location of the crash. This then allows rescue services quicker access to injured persons, and earlier provision of treatment. Below are descriptions of some estimates of the potential effectiveness of ACN systems. Researchers have either employed mathematical models, or have examined in-depth case reports of fatal crashes.

2.6.1 Mathematical Predictive Models

Evanco (1996) describe a mathematical function for estimating the potential benefits of ACN in the US. The benefit estimate is based on mean accident notification time, and the formula derived was:

$$\text{Mean ANT} = f(M)*(1-M) + f(M)*M*(1-S) + 1.0*M*S$$

Where M is market penetration (0-1), S is (cellular) service availability (0-1). The accident notification time function, f(M) is for vehicles not fitted with an ACN (or 'mayday' device as referred to by Evanco, 1996) and f(M=0) is 9.6 minutes for rural areas for zero market penetration.

Evanco (1996), derived a function to determine the change in the number of fatalities as a result of the change in the mean notification time due to an ACN system, where e is the 'elasticity of fatalities with respect to notification time'.

$$\frac{\Delta \text{No. Fatalities (due to ACN)}}{\text{No. Fatalities}} = e \times \frac{\Delta \text{ANT(due to ACN)}}{\text{ANT}}$$

Much depends on the estimate of the elasticity, and Evanco suggest a figure of 0.14.

According to Evanco, assuming 100% market penetration and 100% service availability, a reduction in notification time to one minute would have resulted in a conservative reduction in fatalities of 11.9% (3,069 lives saved in 1990, but note that we were unable to replicate this number). Correspondingly, for lower service availabilities, 80% and 60% respectively, the fatality reductions calculated by Evanco were 9.3% (2,394 lives) and 6.7% (1,727 lives) respectively.

Clark and Cushing (2002) analysed 1997 data from the US Fatal Analysis Reporting System (FARS) where there was a known time of collision, time of EMS notification and time of EMS arrival. They produced a probability mathematical model to determine the effect of each minute passing, from the time of a crash and the effect it had on an individual ‘change in state’ (limited to six hours). They found that “37% of deaths occurred within the first minute. Of the cases with fatal or incapacitating injuries, half died by 110 minutes. For half of surviving cases, EMS had been notified by 4 minutes and arrived by 13 minutes”. Expanding their dataset to include additional cases of incapacitating injuries not included in FARS (based on US Department of Transport’s General Estimates Data), 94% of the cases were still alive after 110 minutes, with half of the surviving cases having the same EMS notification and arrival times as above.

To predict the effect of ACN in their model, Clarke and Cushing (2002) set EMS notification time to one minute. They found with the FARS data, the model predicted 421 fewer deaths (a 1.5% decrease) and with the additional data their probability model predicted 1,674 fewer deaths (a 6% decrease).

2.6.2 Mathematical predictive model of the effect of ACN in Australia

Lahause et al. (2008) used a variation of Evanco’s (1996) model to determine the likely effect of ACN on Australian passenger vehicle occupant fatalities. Lahause et al. used the Australian Transport Safety Bureau (ATSB) fatality numbers and disaggregated them according to the regional distribution of these crash types in Victoria. They assumed ACN would be “95% accurate in notifying a call centre that a serious road crash had occurred and in identifying it’s location”. Based on this, they believed that ACN would have been effective in 95% of the cases.

Unable to source Australian specific crash-to-EMS notification times, Lahause et al. used the times in the US quoted by Champion et al. (1999) to assist in determining the potential fatality reductions in Australia.

Assuming ACN reduces the crash to EMS notification to one minute, Lahause et al. calculated that there would be a 10.5% fatality reduction in urban areas and a 12% fatality reduction in rural areas.

Using fatal crash costs of $1,872,000 per fatality, Lahause calculated that, to produce a benefit-cost ratio of 1.5, ACN would need to cost $120 per vehicle based on the life of a vehicle being 15 years, or $140 based on the life of a vehicle being 25 years. This does not include subscription costs.

2.6.3 Predictive methods based on in-depth crash investigation

Sihvola et al. (2009) evaluated the likely effect of an automated emergency call system on accident outcomes in Finland. They looked at 1,180 fatal crashes that occurred in Finland between 2001 and 2003 that resulted in 1,192 fatalities, of which 919 were vehicle occupants and 261 were unprotected road users. Two medical doctors (accident trauma experts) examined each fatality individually to determine the probable effect of eCall, had it been available throughout all vehicles in the sample.

Each fatality was examined to determine if there was a delay in notification of EMS or any problems locating the crash by the EMS, and whether rapid medical treatment may have improved the patient’s outcome. Eighty per cent of emergency calls were made within 5 minutes of the crash, 13% were made 5-30 minutes after the crash and roughly 3% of cases exceeded 30 minutes before EMS notification. They found the longest delays were associated with vehicles not intended for eCall (motorcycles, mopeds, snowmobiles) and single vehicle accidents. The longest delays occurred on low volume roads, at night, involving single vehicles. Overall, it was found that eCall could decrease the delay in approximately 30% of fatal crashes.

Of 882 fatalities in vehicles intended for eCall, 39 fatalities (4.4% of these fatalities) would have probably been prevented with eCall. There were 37 fatalities involving vehicles not intended for eCall of which 4 fatalities (10.8% of these fatalities) would probably have been avoided with eCall. Overall 43 out of 1,180 (3.6% of all fatalities) would probably have been avoided with eCall.

Interestingly, of the cases where eCall may have prevented the fatality, and perhaps suggestive of the landscape, many were cases of hypoxia (frequently due to drowning) from vehicles being overturned in shallow water or driven directly into water with passengers unable to escape.

Overall, Sihvola et al. found the greatest benefits associated with eCall were for crashes where notification times exceeded 5 minutes. The accurate location information would benefit those crashes on low volume, minor rural roads at night and assist with emergency response centres to correctly locate crashes.

Chauvel and Haviotte (2011) examined crashes involving vehicles that were currently already fitted with eCall in France for the period January 2004 to Mid 2011. In this period, 2,032 eCalls were recorded originating from Peugeot or Citroën vehicles. While the sample was not representative of accidents in France generally, they studied in detail 202 injury crashes (involving 418 occupants) that involved a single vehicle at night in a rural area. The detailed investigations included (where possible) interviews with crash participants and examination of the crashed vehicles so that each occupant was assessed based on expert judgement on 4 levels of eCall usefulness:

- Vital – internal bleeding, amputation, injuries of vital organs.
- Urgent – Loss of consciousness, feel faint, adverse weather conditions
- Useful – single vehicle, night and rural, car victim trapped, nobody gets a GSM, occupants unfamiliar with location, vehicle not visible from road, not witnesses)
- Unnecessary (direct witness at scene, victims uninjured and can call emergency services)

Chauvel and Haviotte (2011) found that for one person eCall was “vital”, for two people eCall was “Urgent” and for 11 people eCall was “useful” with the remaining 404 people eCall was considered “unnecessary”.

This sample and results were then analysed against the 67,104 “injured accidents” (presumably including fatal injuries) in France in 2009 “involving at least one passenger car, without pedestrians or two wheelers”, to determine “global real efficiency” for each of the three levels where eCall was “useful”. Chauvel and Haviotte (2011) found that eCall was likely to have a “useful” efficiency of 2.67%, “urgent” efficiency of 0.47% and “vital” efficiency of 0.18% in general in France. It appears that Chauvel and Haviotte (2011) are suggesting that of the 67,104 “injured accidents”, 119 people may have been saved in France in 2009 had eCall been universally deployed. Relating this to the actual number of fatalities in France in 2009, the Chauvel and Haviotte (2011) estimated that the benefit would be a reduction of 2.8% of all road fatalities in France.

While only a selection of ‘effectiveness studies’ have been discussed, there are many more, with estimates of eCall effectiveness in fatal crashes ranging from as low as 1% to as high as 20% (summarised in Chauvel and Haviotte, 2011 and European Commission, 2009). Similarly, effectiveness rates on serious injury reductions (while not as well studied) can be found in European Commission (2009) indicating a 0.1% increase in injuries (when fatalities change to injuries) and up to a 7% decrease in serious injuries (shifting to less serious injuries).

In summary, estimates of benefits tend to be higher in studies that have used mathematical models. Analysis of fatal crash case files tend to suggest lower levels of effectiveness of around 2.5% to 5%.

3 The potential effect of Automatic Collision Notification on fatalities in South Australia

The objective of this part of the report was to estimate the potential benefits of ACN in South Australia. Three related sets of data were examined: 2008-2009 TARS recorded crash times, SA Ambulance (SAAS) dispatch times to fatal crashes in 2008-2009 as well as available coronial files relevant to those crashes.

3.1 Data and methods

Records of fatal crashes in South Australia were extracted for the period 2008-2009. There were 191 fatal crashes in South Australia in this period, 115 fatal crashes in rural areas, resulting in 133 fatalities and 76 fatal crashes in metropolitan Adelaide resulting in 85 fatalities.

The discrete events required for dispatch of the SAAS in South Australia are (SA Ambulance Service, 2013a,b):

- *t0* Crash Occurrence or Crash Time
- *t1* Recognition of crash by occupants or third party and contact made with Emergency Call Service (Triple Zero call centre) and call diverted to the relevant Emergency Service Organisation or SA Ambulance Service Emergency Operation Centre Emergency Medical Dispatch Support Officers (EMDSOs)
- *t2* SA Ambulance Service emergency medical dispatchers receive information from EMDSOs
- *t3* SA Ambulance Service medical response team dispatched

These discrete time elements *t0* – *t3* are consistent with those discussed in Akella et al. (2003).

Crash times (*t0)* according to TARS were matched against the South Australian Ambulance Service (SAAS) motor vehicle accident (MVA) categorised dispatch times (*t3)* based on reported crash locations in each of the data sets. The SAAS dispatch times were used since SAAS notification times (*t1)* were unavailable for this study. The delay in crash notification to the emergency call service/SAAS emergency operation centre (*t1-t0)* is the most critical period of time in the crash notification process. In the absence of this data, the difference between the dispatch time (*t3)* and the crash time (*t0)* was assumed to be a suitable alternative indicator of the crash notification delay. This delay *(t3-t0)* captures each of the delays following the crash including the crash notification period (*t1-t0).*

Information obtained by the emergency medical dispatch support officers from an emergency caller is electronically transferred to the emergency medical dispatchers immediately following the termination, or even prior to the termination of a call. Hence the delay *(t2-t1)* has a negligible effect on SAAS dispatch times. Further, “the interval from the time an ambulance dispatcher is contacted until an emergency unit begins its response” (*t3-t2),* are typically less than one minute (Mayer, 1980, p80).

Therefore, it can be reasonably assumed, the SAAS dispatch time is largely dependent on the initial delay in crash notification (*t1-t0)* and that the measure (*t3-t0)* is a reasonable surrogate for this delay. Hence, hereafter the period (*t3-t0)* incorporating each of the delays following the crash will be referred to as the ‘EMS notification delay’.

The EMS notification delay data is presented graphically in Figure 3.1 and Figure 3.2 for 100 fatal rural crashes and 54 fatal urban crashes respectively where a positive EMS notification delay was determined. Crashes with negative delays or missing/unknown dispatch times are excluded.

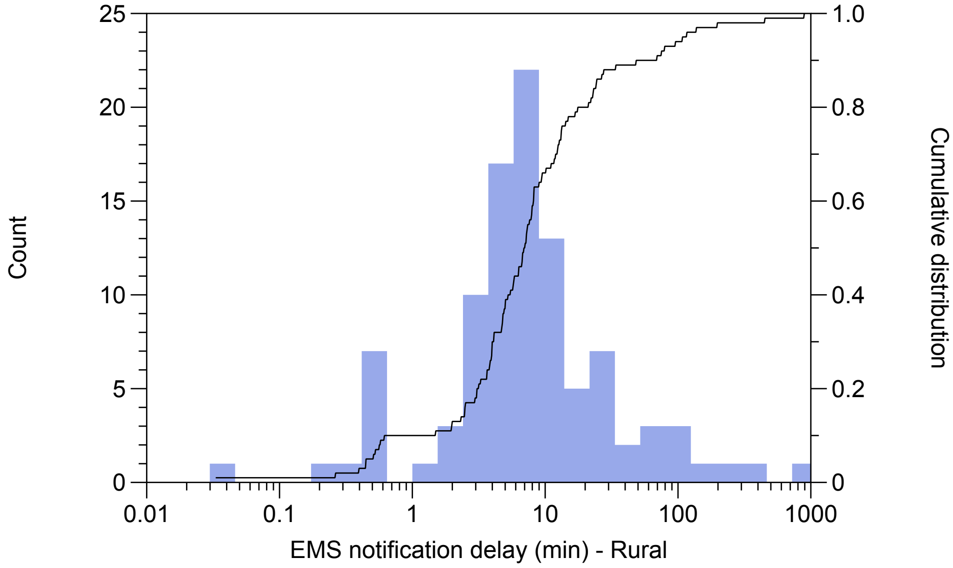

Figure 3.1
Rural fatal crashes and corresponding EMS notification delays.

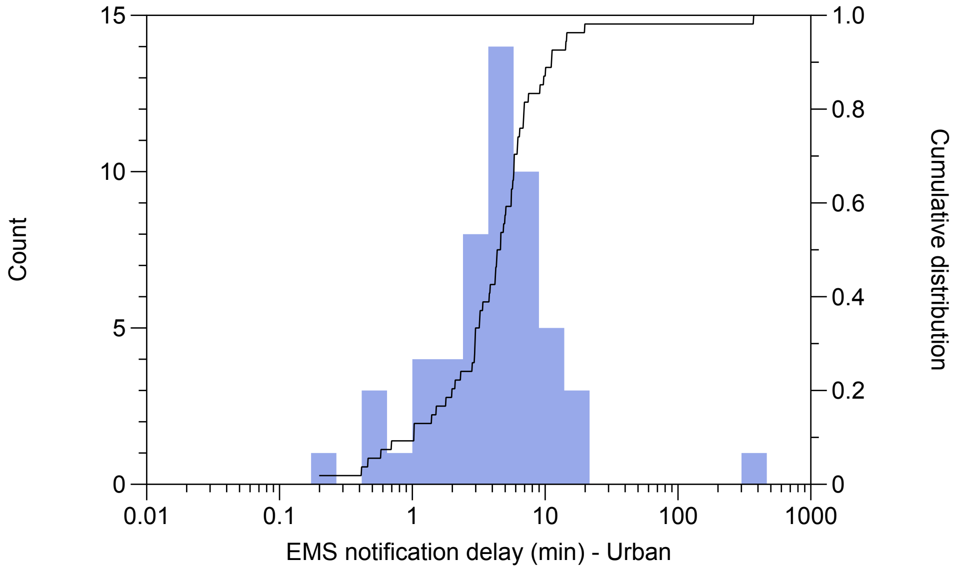

Figure 3.2
Urban fatal crashes and corresponding crash to EMS notification delays.

In some cases the crash times in TARS were recorded as having occurred after dispatch, or dispatch times were missing/unknown, in these cases, coroner's files (where available) were examined to establish whether a more accurate crash time could be estimated or indeed if there was a delay in EMS crash notification. This involved identification of the origin of the triple zero call. Generally the triple zero call was by a person who either witnessed the movements of the crash vehicle prior to the crash (little/no delay), witnessed the crash itself (little/no delay), or was a passer-by (likely delay).

Cases assessed as having 'little/no delay' were assigned the median EMS notification delay determined from the rural and urban EMS notification delay distributions (Figure 3.1 and Figure 3.2). The median EMS notification delays were 7.1 minutes for fatal rural crashes and 4.5 minutes for fatal urban crashes. Cases where a passer-by discovered the crash were examined in more detail and a crash time estimated according to the witness statements.

In individual cases where dispatch data was missing/unknown the (dispatch) data was more carefully examined to establish whether an ambulance had been dispatched but perhaps the reported crash locations differed. This process (and the one described above) resulted in 95% of the fatal crashes being allocated an EMS notification delay (111 rural and 71 fatal urban crashes). This additional data is presented in Figure 3.3 with an expected bias towards median EMS notification delays.

According to Figure 3.3, for fatal crashes in SA for the period 2008-2009, EMS notification delay was less than 5 minutes in around 34% of fatal rural crashes, less than 10 minutes in 70% of fatal rural crashes, and less that 20 minutes in about 83% of fatal rural crashes. The EMS notification delay exceeded 20 minutes in the remaining 17% of fatal rural crashes.

There were fewer crashes with lengthy EMS notification delays in urban areas. The EMS notification delay was less than 5 minutes in around 68% of fatal urban crashes, less than 10 minutes in 91% of the crashes, and less than 20 minutes for 99% of the crashes. In one urban crash the EMS notification delay was several hours after the crash occurred.

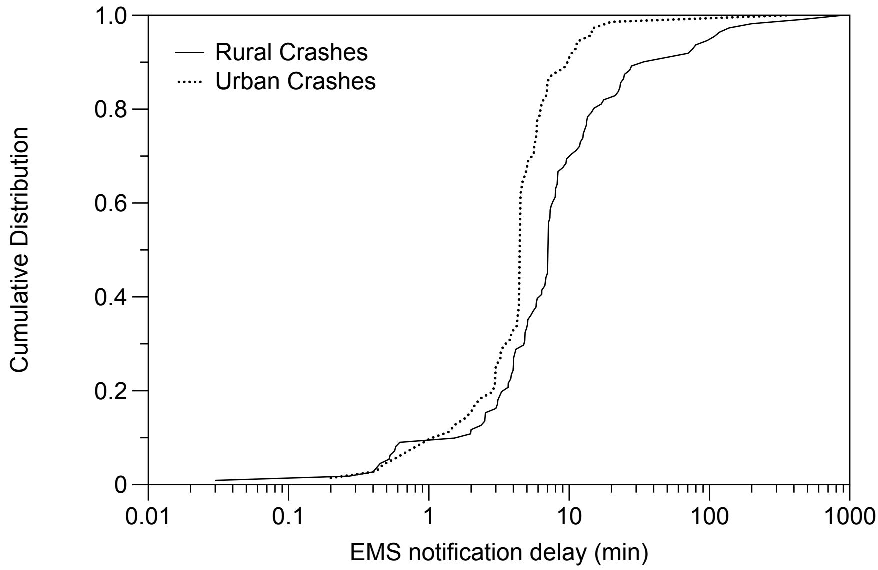

Figure 3.3
Median-adjusted cumulative distribution of EMS notification delays for fatal crashes in rural and urban areas.

It must be acknowledged that while the SAAS dispatch times are automatically generated as result of the SAAS dispatch process and quite precise, there is no precise means for assigning the exact time of a crash (apart from derivation from ACN systems or real-time event recorders, which are currently limited in availability). As a result the TARS recorded crash time is estimated by the Police in charge of writing the vehicle collision report and can only be estimated based on driver or witness accounts or the recorded police crash notification times. The inaccuracy is particularly noticeable for crashes where the apparent EMS notification delay was less than one minute, which is highly unlikely through a manual triple zero notification process, given the crash notification process takes at least this long.

That being said, the data analysed to prepare Figure 3.1 to Figure 3.3 allowed filtering of all the crashes to ascertain which fatal crashes had a compelling delay. Initially only rural crashes with a EMS notification delay exceeding 20 minutes were considered in the analysis, but this was ultimately extended to include urban crashes, and then all crashes with a EMS notification delay exceeding 10 minutes. Hence, the EMS notification delays are initially examined independently and then aggregated.

3.2 Results

3.2.1 In-depth analysis of cases with identifiable delays

Table 3.1 shows a summary of the fatal crashes in SA for the period 2008-2009 considered in the analysis. There were 191 fatal crashes resulting in 218 fatalities. At the time of preparing this report, there were 142 closed coroners files available for examination. Table 3.2 shows the number of fatal crashes, fatalities, available coroner files and the corresponding EMS notification delay in crashes used in this study. In total there were 138 coroner files available for examination that could be grouped within one of the three numerical delay categories, (1) 20 minutes or greater, (2) 10 minutes or greater (but less than 20 minutes) and (3) less than 10 minutes. There were 34 fatal rural crashes (43 fatalities) with an EMS notification delay exceeding 10 minutes with 23 coroners files available for examination. There were seven fatal urban crashes (8 fatalities) with an EMS notification delay exceeding 10 minutes, with 2 coroners files available for examination.

Table 3.1
A summary table showing the relevant information relating to the 191 Fatal Crashes in SA 2008-2009

	Rural			Urban		
Crash Information	Fatal Crashes	Fatalities	Coroner Files	Fatal Crashes	Fatalities	Coroner Files
Relevant dispatch Information	111	129	80	71	80	58
No dispatch time	2	2	1	1	1	1
Inconclusive notification delay	2	2	0	4	4	1
Not relevant	0	0	0	0	0	1
Total	115	133	81	76	85	61

Table 3.2
A summary of the relevant information pertaining to the fatal crashes with identifiable EMS notification delay

	Rural			Urban		
EMS Notification delay	Fatal Crashes	Fatalities	Coroner Files	Fatal Crashes	Fatalities	Coroner Files
Greater than 20 minutes	20	25	18	1	2	2
Greater than 10 minutes (< 20)	14	18	5	6	6	0
Less than 10 minutes	77	86	57	64	72	56
Total	111	129	80	71	80	58

A medical expert with significant experience in road crash investigations and road crash trauma examined the coroner's files that were available for the 23 rural fatalities and the two urban fatalities with a delay exceeding 10 minutes. The coroner's files were examined to see whether the delay was a significant factor in the resulting fatality. Each fatality was categorised according to whether ACN would have had a 'likely' benefit, that is, if the injured occupant would have been likely to have survived if emergency medical assistance had been provided faster. A 'potential' benefit was assigned if the fatally injured occupant potentially would have survived if surgical intervention could have been provided at the crash site or emergency medical assistance could sustain life until surgical intervention occurred at a hospital. A result of 'no benefit' was assigned where the fatality was the result of a single or multiple injuries that were beyond the capability of medical or surgical intervention.

Four rural crashes were excluded from the benefit analysis:

- In one case, there was no EMS crash notification time available and on further examination it was found there was a significant delay in seeking medical assistance. However, there was no cellular coverage and earlier emergency medical assistance would not have influenced the outcome.
- In one case, no dispatch time was available, nor was a coroner's report available.
- In two cases there was an undefined delay as the crash time was recorded occurring after dispatch, and a coroner's report was not available for examination to validate whether there was an EMS notification delay.

Six urban crashes were excluded from the benefit analysis:

- In one case, there was no EMS crash notification and, on examination, it was found there was a slight delay in seeking medical assistance. In this case, only a manual collision notification may have assisted, however there would have been no difference in the fatal outcome.
- In four cases there was an undefined delay as the crash time was recorded occurring after SAAS dispatch, and a coroner's report was not available for examination to validate whether there was an EMS notification delay.
- One case was 'not relevant' for the analysis (not a typical public road crash).

Table 3.3 summarises the assigned benefits for the fatalities involving a delay in EMS notification.

Table 3.3
A summary of the coroner cases examined by area and by EMS notification delay

	Rural Benefit			Urban Benefit		
EMS notification delay	Likely	Potential	None	Likely	Potential	None
Greater than 20 minutes	2	1	15	1	1	0
Greater than 10 minutes (< 20)	0	1	4	0	0	0
Total	2	2	19	1	1	0

Rural Fatalities

In 19 of the fatalities, regardless of the notification delay, the trauma sustained by those fatally injured was at a severity beyond the capability of medical intervention. In two cases more prompt primary medical intervention would have likely led to the survival of a car driver:

- In one fatal crash, the driver was undiscovered for 15 hours before EMS notification.

- In the other crash, the crash was not discovered for 75 minutes before EMS notification.

In two fatalities, had surgical intervention occurred without delay (or life could be sustained until surgical intervention), the car driver fatality could potentially have been avoided.

- In one fatal crash, the driver was undiscovered for 109 minutes before EMS notification.
- In the other crash, the crash was not discovered for at least 10 minutes before EMS notification.

In another case the fatality was likely due to the combined result of a medical condition that may have been brought about by the crash trauma. It is possible that had early medical intervention occurred to address the crash trauma the car occupant may have potentially survived. However, due to the remote location of the crash, there was no cellular coverage so an ACN notification would not have been successful, and hence was assigned no benefit.

Urban Fatalities

The two fatalities with a significant delay in the urban area were both the result of the same fatal crash. In this fatal crash it was likely that the occupant in the vehicle would've survived and the driver potentially survive if ACN had been available. It must be noted that while the location of the crash was defined as 'urban' the road environment and surrounds at the crash site were characteristic of a rural environment: an 80 km/h per hour tree lined road protected by guard rail with sparse open land either side of the road way. The crash most likely went unnoticed due to the environment.

3.2.2 Effectiveness Rates

The effectiveness of ACN in this analysis is based on the sample of fatalities that have associated coroner's files as shown in Table 3.2. Table 3.4 shows the effectiveness of ACN for the particular sample for the various EMS notification delays.

Table 3.4
ACN effectiveness for the fatalities identified with various EMS notification delays

	Rural Benefit			Urban Benefit		
EMS notification delay	Likely	Potential	None	Likely	Potential	None
Greater than 20 minutes	11.1%	5.6%	83.3%	50.0%	50.0%	0.0%
Greater than 10 minutes (< 20)	0.0%	20.0%	80.0%	0.0%	0.0%	0.0%
Greater than 10 minutes	8.7%	8.7%	82.6%	50.0%	50.0%	0.0%
Any fatality in sample	2.5%	2.5%	95.0%	1.7%	1.7%	96.6%

It must be emphasised that these rates apply specifically to the sample considered. For example, for the particular sample of crashes in the rural area, where the EMS notification delay exceeded 20 minutes, ACN is likely to have reduced fatalities by 11.1% (N=18). While the urban benefit appears much higher at 50% (N=2), this is most likely a result of the very small sample size. Table 3.5 shows the aggregated rural/urban benefit of ACN.

For EMS notification delays exceeding 10 minutes (N=25) the estimated minimum likely ACN benefit is 12%, but potentially as high as 24%. For all crashes in the sample with a coroner's file (N=111), including those without a significant delay the minimum estimated ACN benefit is 2.2%, but potentially as high as 4.4%.

Table 3.5
State wide benefit of ACN based on sample

	Aggregated ACN Benefit		
EMS notification delay	Likely	Potential	None
Greater than 10 minutes	12.0%	12.0%	76.0%
Any fatality in sample	2.2%	2.2%	95.7%

It is important to note that little is known about the fatalities with an EMS notification delay of less than 10 minutes with a coroner's file (N=113) as these were not examined. This analysis assigns no ACN benefit to these fatalities and hence the minimum benefit estimated above may be underestimating the true 'global' benefit of an fully deployed ACN system in South Australia.

3.2.3 Limitations

At the time of writing, of the fatal crashes identified as having a delay exceeding 10 minutes 47% rural and 75% urban fatal crashes had no coroner's file available to examine. It is therefore possible that there are additional cases where an ACN system may have had a benefit. The estimated benefits in this report are likely to be conservative.

Another limitation is a reliance on TARS recorded crash times, which may not be recorded with precision or certainty. While obvious inaccuracies were excluded from the sample and adjustments were made, the delay times reported in the figures above are probably subject to some error. However, for the crashes identified as having a delay (>10 minutes), the delays calculated from the TARS record of each crash were consistent with information within the coroner's files.

There were indications that ACN effectiveness may be limited in South Australia by network coverage. One case was identified where early medical intervention may have potentially prevented the fatality but where there was no network coverage that would have enabled the collision notification.

4 Cellular network coverage in South Australia

In any analysis of a collision notification system, 'operational effectiveness', needs to be assessed, that is, the ability for the system to:

- detect the 'collision' (ideally ensured by the system and vehicle manufacturer)
- receive satellite signals for location purposes (clear line of sight of the sky)
- successful transmission of the crash notification and location details to the relevant parties.

While many studies assume ACN 'operational effectiveness' (eg Lahause et al., 2008 assumed 95%, Chauvel and Haviotte, 2011 assumed 100%) we sought to undertake a closer analysis of the cellular network coverage in South Australia. Specifically looking at the Telstra network coverage (which current ACN systems operate within) we examined a relevant sample of crashes in South Australia, to determine the distribution of crashes relative to the available network coverage.

4.1 Method

In the period 2006-2011, there were 5,746 serious injury and 603 fatal crashes in South Australia. Rural crashes accounted for 44.7% of serious injury crashes and 57.5% of fatal crashes in this period. It is for these crashes that ACN would be considered to have the greatest potential benefit (Donnely et al., 1995; Sihvola et al., 2009). Table 4.1 shows the annual number of crashes in rural South Australia, by severity.

Table 4.1
Crashes by severity, in rural South Australia 2006-2011

Year	Serious Injury	Fatal	Total
2006	473	54	527
2007	478	63	541
2008	440	47	487
2009	414	68	482
2010	408	61	469
2011	361	54	415
Total	2574	347	2921

As mentioned, the collision notification systems that are currently hosted by Australian vehicles use the Telstra GSM network boosted with an external antenna system. Telstra provide network coverage maps for both the GSM network and Next G® network (Telstra, 2012) for:

- GSM handheld
- GSM handheld in a car kit fitted with an external antenna
- Next G® Voice, Picture, TV, Video & Broadband
- Next G® Voice, Picture, TV, Video & Broadband with an external antenna

For each of the 2,921 crashes, the longitude and latitude coordinates, as geocoded in TARS, were manually entered into the Telstra network coverage search map, to determine whether a particular crash was within a Telstra network coverage area.

4.2 Results

The crash distributions of serious injury and fatal crashes in Table 4.1 are shown in Figure 4.1 and Figure 4.2 with the corresponding Telstra coverage for the GSM and Next G® networks. The proportion of crashes that fell within one of the four coverage areas are summarised in Table 4.2 to 4.5. Within the sample of crashes, 11% of crash locations were not coded in TARS and so the coverage for those crashes could not be established.

The current GSM based ACN would have been able to make a successful collision notification in at least 72% of serious and fatal rural crashes (Table 4.3). A transition to the Next G® network could potentially improve notification to at least 78% (and up to 89%) for a handset based system, or at least 84% (and up to 96%) for handset systems with an external antenna. It is particularly important to consider the Next G® handset and Next G® with antenna distinctly, as current generation OBD2 'alert' systems, smartphone application systems and systems such as SYNC® Assist™ as they rely on handset coverage while the next generation ACN systems may utilise external antenna systems.

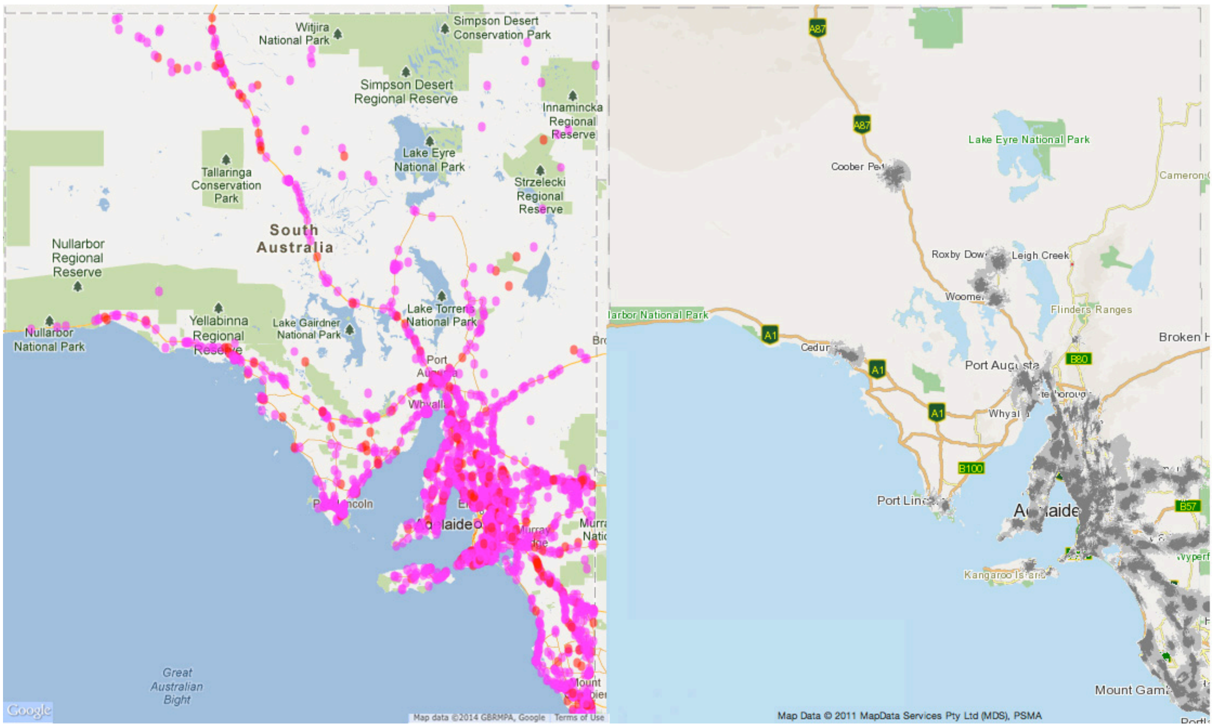

Figure 4.1
(Left) Distribution of rural serious injury and fatal crashes in SA 2006-2011 from TARS and (Right) the GSM network coverage map for SA, 2012. The dark areas indicate GSM handheld coverage, the lighter areas indicate the extended GSM coverage with external antenna (Telstra, 2012)

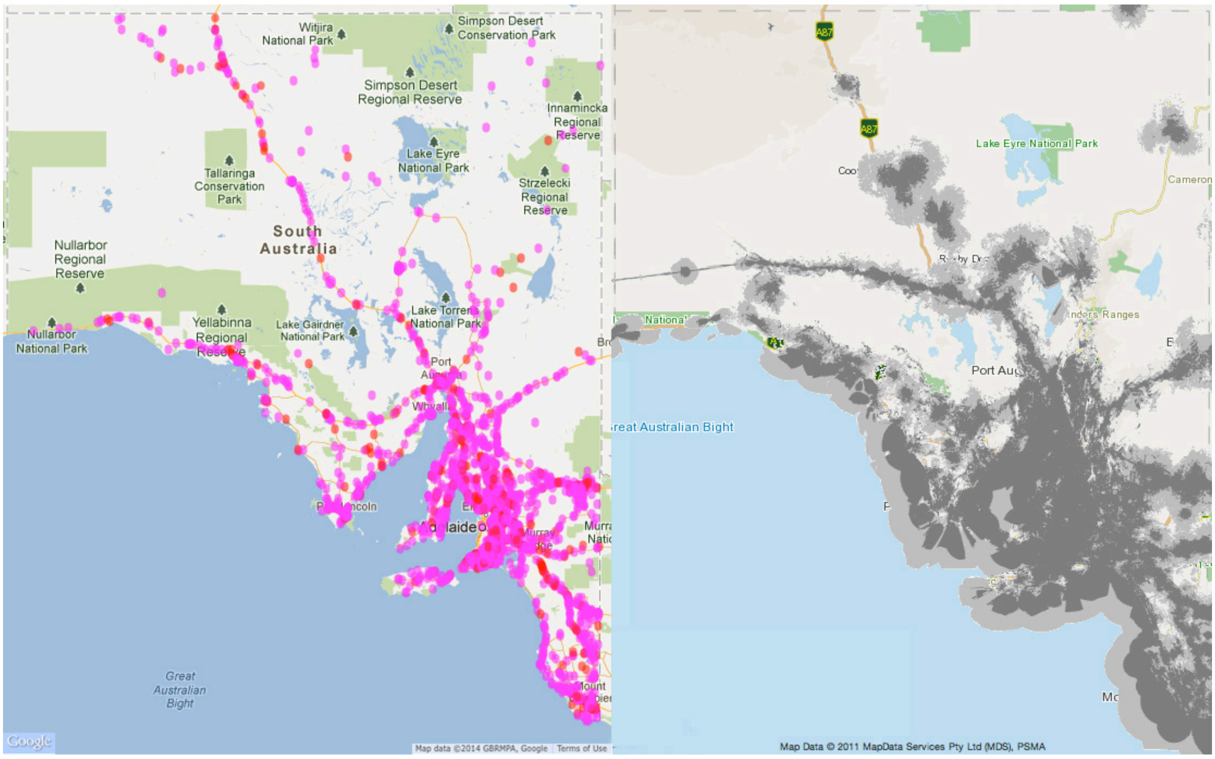

Figure 4.2
(Left) Distribution of rural serious injury and fatal crashes in SA 2006-2011 from TARS and (Right) the Telstra Next G® network coverage map for SA, 2012. The dark areas indicate Next G® handheld coverage, the lighter areas indicate the extended Next G® coverage with external antenna (Telstra, 2012)

Table 4.2
Proportion of crashes covered by Telstra's GSM handheld network

Cellular Type	Serious Injury	Fatal	Total
GSM no Coverage	26.3%	4.2%	30.6%
GSM coverage	51.0%	7.5%	58.5%
Unknown crash location	10.8%	0.1%	11.0%
Total	88.1%	11.9%	100.0%

Table 4.3
Proportion of crashes covered by Telstra's GSM handheld in a car kit fitted with an external antenna

Cellular Type	Serious Injury	Fatal	Total
GSM+ no coverage	14.7%	2.4%	17.0%
GSM+ coverage	62.6%	9.4%	72.0%
Unknown crash location	10.8%	0.1%	11.0%
Total	88.1%	11.9%	100.0%

Table 4.4
Proportion of crashes covered by Telstra's Next G® handheld network

Cellular Type	Serious Injury	Fatal	Total
Next G® no Coverage	9.4%	1.4%	10.9%
Next G® coverage	67.9%	10.3%	78.2%
Unknown crash location	10.8%	0.1%	11.0%
Grand Total	88.1%	11.9%	100.0%

Table 4.5
Proportion of crashes covered by Telstra's Next G® handheld and external antenna network

Cellular Type	Serious Injury	Fatal	Total
Next G® + no Coverage	4.1%	0.7%	4.8%
Next G® + coverage	73.2%	11.1%	84.2%
Unknown crash location	10.8%	0.1%	11.0%
Total	88.1%	11.9%	100.0%

5 Automatic Collision Notification Status in Australia

There are vehicles that are currently in the Australian fleet that are fitted with ACN systems. The prevalence of these systems is not well established. ACN has been installed in both Toyota vehicles and Holden Vehicles. The telematics service provider for these systems is Intelematics Australia Pty Ltd.

Based on all information available to the authors, since 2004, approximately 10,000 vehicles have been manufactured and installed with an ACN system in Australia. According to the ABS (2012) the number of registered passenger vehicles in Australia in 2012 was 12,714,235 and total registered vehicles 16,741,644. If one assumes that all 10,000 of the ACN-equipped vehicles were still functional and being driven on Australian roads, the current deployment rate of ACN in Australia would be 0.08% of the registered passenger vehicle fleet or 0.06% of the total registered fleet. Realistically however, these figures are likely to be much lower, given that these vehicles have a particular ‘mortality rate’, and owners may not have renewed their subscription to Intelematics Australia.

5.1 Toyota

Based on correspondence with Toyota Australia, the Toyota telematics program was introduced in 2004, as a standard fit to the highest grades of vehicles (August 2004 - July 2006 Camry V6 Azura, Camry V6 Grande, 2011 Aurion Presara) with a 3-year ‘gifted’ subscription to Toyota’s “Customer Care” program. Primarily, the telematics system offered a direct communication between the vehicle, either directly via the driver through an “automatic call’ (ToyotaLink) button (in the case of an emergency or roadside assistance) or automatically in an emergency. The airbag electronic control unit (ECU) in these vehicles was manufactured with a special output and was connected directly to the collision notification ECU. In the event of any airbag deployment[3] a signal from the airbag ECU would be delivered to the Collision Notification ECU. An SMS via the vehicle telematics would be transmitted to the customer care centre with the information that an airbag has deployed, the GPS location of the vehicle and other minimum information (vehicle ID, vehicle owner details).

Voice communication through the integrated cellular phone system is then attempted with the vehicle’s driver or occupants and a request can be issued for emergency services by call centre personnel.

As mentioned previously, in Australia, the emergency protocol involves the TSP calling triple-zero, and supplying information from the vehicle message to emergency services and police.

From August 2012, Toyota Australia no longer supplies the ACN system on any vehicle in Australia, but the system on existing vehicles will be supported (under renewed TSP subscription arrangements) for at least another 6 to 7 years. The reason it is no longer being supplied on vehicles is the impending closure of the GSM network. Upgrading the ACN system to a new telecommunications network (eg 3G or 4G) would require further investment in development and extensive testing.

[3] Additionally the line is monitored for open or short circuits. Whether the line is cut or short-circuited in an accident (or at any other time), a message/phone call is made to the call centre.

It is important to note that there may be legal ramifications if there is a failure in a supplied ACN system, and there is a duty of care to customers. As a result, manufacturers are unlikely to release any system until it has been rigorously tested and is demonstrably robust enough to guarantee performance.

5.2 GM Holden

GM Holden's automatic collision notification (and manual SOS button) operates in similar manner to that of Toyota's system. The telematics system design and telematic service provision was undertaken by Intelematics Australia Pty Ltd under the "Holden Assist Ultra" programme. Notification can also be triggered by an airbag deployment or through the deployment of the seatbelt pre-tensioners.

According to a Holden (2007a):

> "Holden Assist Ultra currently supports around 5000 customers and in the last 12 months has unlocked more than 360 cars remotely, detected 17 crashes and tracked 14 stolen vehicles. It has also provided SOS support in over 600 cases. Holden Assist Ultra is priced at $1990 plus GST and fitment, and includes three years service. It can be fitted to all VE Commodore sedan & Ute models and WM Statesman and Caprice."

Vehicles available for non-factory fitment of the telematics program incorporating Holden Assist Ultra include Holden Omega, SV6, SS, SS V-Series, Berlina, Calais. Additionally the Holden Calais V-Series, Statesman and Caprice had a factory fit option (Holden, 2007b). The only information related to uptake is the 5,000 customers that Holden Assist Ultra supports quoted in Holden (2007a).

Additional information, according to personal correspondence with Holden Corporate Affairs, is that the program outlined in the 2007 media release (Holden, 2007a) has concluded and the service is no longer offered on new vehicles. Further, it was conveyed that telematics system or features such as ACN are no longer available or sold on any Holden vehicles.

5.3 Ford

While Ford have been active with Automatic Collision Notification systems in the US, and most recently with their "SYNC® 911 Assist™" system, currently no Ford vehicles in Australia are fitted with any ACN systems. However, it was recently announced at the 2012 Sydney Motorshow that "Triple Zero Emergency Assist" is planned in the roll-out of future Ford vehicles in Australia with Ford's "SYNC™" system.

5.4 Mitsubishi

In Australia, no Mitsubishi vehicles are fitted with Automatic Collision Notification systems. While the Lancer Evolution 9 was fitted with a telematics device (supported by Intelematics Australia Pty Ltd), it was purely for addressing vehicle theft and location purposes and for handsfree communications. According to Mitsubishi Australia, when the gifted subscription ended, most vehicle owners chose not to renew the service.

5.5 Subaru

In Japan (and China), Subaru owners have optional access to the G-Book telematics service. This service is not available in Australia, and while it is “Toyota Technology”, Subaru have no information as to whether this service will be available in Australia.

5.6 Hyundai

Hyundai offer Automatic Collision Notification as part of their Blue Link® “assurance” telematics package in some vehicles in the US, but no Hyundai vehicles in Australia are currently available with this system. While it is likely that it will be rolled out in Australia in the future, a date for this has not yet been decided.

6 Discussion

Automatic collision notification systems have the potential to reduce the number of road crash fatalities, and it is possible to identify individual cases in South Australia that might have benefited from ACN. The extent of these reductions is not conclusive, but the proportion of fatalities appears to be in the order of less than 5%.

A number of international studies predicting the effect of automatic collision notification systems were reviewed for this report. These studies generally assumed full deployment and various levels of estimated cellular coverage, and they estimated effectiveness levels between 2.8% to 11.9%. The effectiveness rates in reducing fatalities across other studies not reviewed here have ranged from as low as 1% to as high as 20% (summarised in Chauvel and Haviotte, 2009 and European Commission, 2009).

A previous estimate for the benefits of ACN in Australia was calculated by Lahause et al. (2008), who estimated a 10.5% fatality reduction in urban areas and a 12% fatality reduction in rural areas. That is 103.7 lives annually would be saved in Australia with full deployment of ACN with 95% effectiveness.

In this report we have attempted to determine the potential benefit of ACN within South Australia based on a sample of fatal crashes in 2008-2009. There were three fatal crashes, resulting in three fatalities, that would have benefited from ACN on the basis of quicker medical attention. In addition, there were three fatal crashes, resulting in another three fatalities where there was some potential benefit, but this was on the basis of immediate surgical intervention. A fourth fatality may have possibly been prevented but it was found there was no cellular coverage for this particular crash.

There were a number fatal crashes with significant EMS notification delays where coroner's files were not yet available, and it is possible in some of these cases ACN may have made a difference. Similarly, there were also 158 fatalities with EMS notification delays of less than 10 minutes of which 113 had coroner's files. These files were not examined, and hence any positive ACN benefit could not be assigned to any of these fatalities.

The minimum effectiveness rate of an automatic collision notification system in South Australia (with full deployment) is in the range of 2.2% - 4.4% of all fatalities (with a coroner's file). If the assumption is made that these fatalities are representative of all 218 fatalities in SA for the years 2008-2009, then it expected that ACN has the potential to save at least two lives per year, but perhaps as many as four lives per year in South Australia. According to BITRE (2011), 2,925 Australians were killed between 2008 and 2009 in road crashes. Assuming the same effectiveness rates for SA could be applied across Australia, ACN has the potential to save almost 32 lives per year and as many as 64 lives per year Nationwide.

The benefits of a post crash technology such as ACN, while offering a final opportunity to save lives in a crash, diminish with increasing prevalence of pre-crash technologies such as collision avoidance systems (electronic stability control and autonomous emergency braking). There is further diminishing effectiveness with increasing prevalence of in-crash systems that reduce injuries (seatbelts, airbags, increased occupant cell and roof strength. etc). This is particularly relevant to the types of crashes that benefited from ACN in the sample examined here, all single vehicle crashes with vehicle ages between nine and 30 years old. It is likely that these crashes in the future would not occur, or if they did, the occupants would be better protected with diminished injury severity.

Though ACN systems exist in vehicles in Australia (albeit less than 0.06% of the registered vehicle fleet), the impending closure of its supporting cellular network (GSM) will drive these systems into obsolescence. The next generation of telematics and telematics based collision notification devices are likely to be arriving in Australia on imported vehicles in the future, and new generation collision notification devices independent of telematics service providers (eg Ford Sync Triple Zero assist) are likely to arrive even sooner.

For telematics based systems, it is still uncertain as to whether Australians would undertake long term paid subscription to access the 'benefits' of telematic services (including ACN) through providers, when ultimately, systems such as ACN may never actually prove useful over the life of the vehicle or over the life of a typical driver.

There is some anecdotal suggestion, that after the gifted period of subscription ends, they are rarely renewed. It is for this reason, that the European Parliament's push to mandate ACN on all vehicles and that it "should be public, free of charge and obligatory" has the greatest potential for increasing deployment of ACN type systems.

Similarly, non-subscription based systems such as the Ford Sync Assist which use a driver's mobile phone, have enormous potential for increased deployment of ACN, although systems such as these need to be considered carefully, in terms of robustness and in terms of the effect it may have on the National Triple Zero system in Australia.

The benefits of plug-in-type devices such as those discussed in this report may also have some potential benefit, especially in that there is essentially no cellular coverage issues for those devices using the Iridium satellite system. It may be suggested that perhaps employers should consider these systems for remote work vehicles for OH&S purposes, with monitoring in-house. The costs of full coverage, however, are high, and the message system generation is not currently conducive to immediate emergency response. It seems that if these sensor integrated systems could utilise a driver's mobile phone, be it cellular or satellite, there may be further potential for these devices to be retrofitted to existing vehicles.

Network coverage in South Australia was examined and is still potentially problematic for ACN (in remote crashes, where ACN is likely to be of most use), even on the Next G® cellular network. While the analysis found that at least 78.2% – 84.2 % of rural crashes had coverage under Telstra's Next G® network, there were 11% of crashes that could not be verified.

Privacy issues have not been specifically discussed in this report, but were raised as an important issue by a particular vehicle manufacturer. They maintained that the tracking capability of a GPS embedded telematics system should be accessible only by the vehicle owner in general circumstances (and this was enabled through a web based portal) and that the vehicle location only be disclosed to Police or other emergency services for emergency purposes and not to be used to the vehicle owner's disbenefit (eg. by insurance companies). This is similar to Holden's privacy statement for Holden Ultra Assist owners. However, they may disclose vehicle movements if required to do so by a court order (Holden, 2007c).

The European Commission (2009) in addressing data protection, indicate that locating systems should remain dormant until an emergency incident is triggered, and vehicle tracking should not be allowed. Some US AACN systems record vehicle location and speed history prior to crash but to what extent this information can be used to the drivers dis-benefit remains to be seen.

The ‘real’ benefits of ACN are not yet able to be determined accurately. Deployment is currently slow, and it remains to be seen whether the push by the European Parliament to make the systems mandatory in the EU Member States will ultimately be successful. Basic systems have evolved into advanced, data rich systems. Material benefits of collision notification systems may not be seen for several years, even in countries such as the US, until deployment rates have improved.

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